08-17-00

A

PATENT APPLICATION TRANSMITTAL LETTER

Docket Number
3869/59156-083

To the Assistant Commissioner for Patents, Box Patent Application:

Transmitted herewith for filing under 35 U.S.C. 111 and 37 CFR 1.53 is the patent application of **Dr. Norbert Diekhans** entitled **COMBINE WITH A DEVICE FOR AUTOMATIC CLEANING REGULATION.**

Enclosed are:

[X] 13 pages of written description, claims and abstract

[X] 2 sheets of drawings

[X] executed declaration of the inventor

[X] an assignment of the invention to CLAAS Selbstfahrende Erntemaschinen GmbH and recordation Form PTO-1595

[X] information disclosure statement and Form PTO-1449, including copies of 14 references

[X] preliminary amendment

[X] other: **return receipt postcard**

CLAIMS AS FILED

	NUMBER FILED	NUMBER EXTRA	RATE	FEE
BASIC FEE			**$690**	**$690**
TOTAL CLAIMS	**17 – 20 =**	**0**	**x $18**	**$0**
INDEPENDENT CLAIMS	**3 - 3 =**	**0**	**x $78**	**$0**
MULTIPLE DEPENDENT CLAIM PRESENT			**$260**	**$0**
*NUMBER EXTRA MUST BE ZERO OR LARGER		**TOTAL**		**$690**
If applicant has small entity status under 37 CFR 1.9 and 1.27, then divide total fee by 2, and enter amount here.		**SMALL ENTITY TOTAL**		**$**

[X] A check in the amount of **$690** to cover the filing fee is enclosed.

[X] A check in the amount of **$40** to cover the assignment recordation fee is enclosed.

[X] The Commissioner is hereby authorized to charge and credit **Deposit Account No. 08-3460** as described below. I have enclosed a duplicate copy of this sheet.

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- [ ] Charge the issue fee set forth in 37 CFR 1.18 at the mailing of the Notice of Allowance, pursuant to 37 CFR 1.311(b).

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Respectfully submitted,

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PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of Dr. Norbert Diekhans)
Application No. (Unassigned))
Filed: Herewith)
For: *Combine With a Device for*)
Automatic Cleaning Regulation)
Attorney Docket No. 3869/59156-083) Peoria, Illinois 61602-1241

16 August 2000

Honorable Director of the United States
Patent and Trademark Office
Washington, D.C. 20231

PRELIMINARY AMENDMENT

Sir:

Preliminary to issuance of the First Office Action, please amend the above-identified patent application as follows:

In the Specification

Page 2, line 8, change "DE 27 53 503 A1" to — DE 27 53 505 A1 —

Page 5, lines 11-12 following "Generally," delete "the sensor 4" and insert – a sensor –

Page 5, line 12, delete "1"

Page 5, line 29, delete "The" and insert – A –

Page 6, line 20, delete "The sensor 4, whose measuring signal S/4" and insert – A sensor 4 is located a distance from the cleaning mechanism 1. The sensor 4 is indicated schematically and has a measuring signal S/4 which"

Page 6, line 22, delete ", is only indicated schematically"

Page 6, line 23, before "As already mentioned," insert – Hence the signal S/4 is independent of the setting of the cleaning mechanism 1. –

In the Claims

Please add the following new claim:

17. (New) A combine harvester incorporating a cleaning mechanism which comprises a sieve for cleaning the crop produced by the threshing and separating mechanisms, a fan for forcing a blast of air through the sieve device, an adjusting member for automatically adjusting the opening widths of the sieve device, at least one sensor having a test signal which is a measure of the loading to which the cleaning mechanism is subjected, whereby the adjusting of the sieve opening width is effected automatically only in dependence on the test signal from the sensor.

Remarks

The amendment to page 6, line 23, of the specification incorporates language found in claim 1. A typographical error and other minor irregularities have also been corrected by the above amendments. Changes have also been made to improve readability.

New independent claim 17 is similar to the main claim allowed in the corresponding German application.

It is respectfully requested that the First Office Action be directed to the application as hereby amended.

Respectfully submitted,

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Combine With a Device for Automatic Cleaning Regulation

This application is a continuation of PCT Application No. PCT/EP99/00963 filed 13 February 1999 and which named the United States as a designated country.

The invention relates to a combine harvester incorporating a cleaning mechanism which comprises a sieve device including at least one sieve for cleaning the crop produced by the threshing and separating mechanisms and at least one adjustable fan for forcing a blast of air through the sieve device, whereby the opening widths of the sieve device and/or the speed of the fan are adjustable by means of at least one adjusting member.

The threshed crop produced by the threshing and separating mechanisms is mixed with chaff and short lengths of straw. The cleaning mechanism serves for separating the crop from these additional constituents. The blast of air emerging through the sieve openings separates the crop-chaff-short-straw mixture that has been fed onto the sieve device and causes the specific lighter chaff and short straw components to be separated out whilst allowing the heavier grains of the crop to fall through the sieve openings onto the catching and feed pans from where they are supplied to a grain auger which feeds the cleansed crop via an elevating conveyor into the grain tank. An optimum setting for the cleaning mechanism (i.e. fan speed and/or sieve opening width) has been attained when the crop can be harvested without losses and in a cleansed form i.e. separated from the chaff and short lengths of straw.

The setting of the cleaning mechanism is effected prior to harvesting in dependence on the type of crop and in accord with certain standard values or by using values based upon experience. To this end, the fan speed and the opening widths of the sieve device are generally set manually from the driver's cab.

Now in order to find the optimum setting, care must be taken to ensure that the crop-chaff-short-straw mixture located above the sieve is subjected to an adequate quantity of air and that the speed and direction of the blast be correct.

The composition of this mixture is dependent on a plurality of parameters specific to the crop such as, for example, the moisture contents of the crop and the straw, the type of crop and also the settings of the threshing and separating mechanisms.

Another important factor affecting the quality of the cleansing process is the quantity of crop-chaff-short-straw mixture with which the cleaning mechanism has to deal. This, in turn, depends on the instantaneous throughput of the crop.

A monitoring and regulating arrangement is proposed in DE 27 53 503 A1 wherein the air pressure in the cleaning mechanism, i.e. the air pressure in the region between the sieves and the fan, is detected and indicated by means of appropriate sensors. Also, in one embodiment of the invention, the cleaning mechanism is automatically set in dependence on this measured air pressure. It was assumed therein that the flow resistance of the air in the cleaning mechanism, and hence too, the air pressure therein, was proportional to the amount of material passing through the cleaning mechanism.

In general, the air pressure in the cleaning mechanism is dependent on the crop itself and also upon the setting of this mechanism. The air pressure is affected by the flow resistance in the cleaning mechanism and by the setting of the fan. Thus, it is affected by the composition and the quantity of crop in the cleaning mechanism, and also by the setting i.e. the opening width of the sieve in the cleaning mechanism. Consequently, the proposed method of determining the throughput of material in the cleaning mechanism only provides a reproducible indication in regard thereto when all the other relevant parameters remain unaltered and when it is only the throughput that varies. Thus, for example, if the throughput in the cleaning mechanism increases, this will be indicated by an increase in the air pressure. It is then necessary to alter the setting of the cleaning mechanism to adapt to this increased throughput for optimum functioning of the cleaning mechanism. However, this alteration simultaneously alters the relationship between the air pressure and the throughput of material. Consequently, it is not possible to regulate the setting of the cleaning mechanism

on the basis of the measured air pressure due to the fact that the setting of the cleaning mechanism has an effect upon the air pressure. If, for example, the opening width of the sieve is automatically altered on the basis of a detected change in air pressure, then a new flow resistance value will be created as a result of the alteration in the flow resistance of the sieve and the alteration in the flow resistance of the material. Consequently, the air pressure as determined after the change in the sieve opening can no longer be unambiguously related to the then existing throughput of the material. Hence, the use of the air pressure prevailing in the cleaning mechanism as a means for automatically setting the cleaning mechanism does not represent a practicable solution to the problem.

In order to compensate for alterations in the loading imposed on the cleaning process, it was proposed in DE 44 25 453 C1 that the rotational speed of the fan be regulated in dependence on the speed of the air blast as measured above the sieve device, or, upon the pressure as measured thereabove. A disadvantage of this manner of automatically adjusting the setting of the cleaning mechanism is that the pressure or the speed of this blast of air does not provide a direct measure as to the quality of the cleansing action. Furthermore, a change of rotational speed can only be effected in a relatively slow manner so that it is not possible to react to every variation in the measured values. In addition, the pressure or the speed of the air blast can only be measured at particular points so that these measurements will not always be representative for the whole of the cleaning mechanism.

Consequently, an object of the invention is to provide a combine harvester wherein the optimum setting for the cleaning mechanism is derivable from a value that is truly representative of the loading on the cleaning mechanism.

This object is achieved by the special features defined in Claim 1. Further developments of the invention are specified in the appendant claims.

In accordance with the invention, there is provided a sensor whose measuring signal provides a direct or indirect measure of the loading to which the combine harvester, and in particular, the cleaning mechanism, is subjected

whereby the setting of the cleaning mechanism is effected in dependence on this signal by means of a known adjusting member. Thus, for the first time, it is then possible to optimally set the cleaning mechanism in dependence on the throughput of the crop.

In a first embodiment, the setting of the cleaning mechanism is implemented by altering the opening width of the sieve. This enables the quality of the cleansing process and the losses entailed therein to be adjusted over a very wide range thereby resulting in an optimum cleansing action. Preferably, provision is made for setting both the upper and the lower sieves in accord with this inventive process, whereby, as a limiting case of the invention, it is of course possible for the opening width of just one of the sieves to be adjusted in dependence on the signal from the sensor. Furthermore, in one advantageous embodiment of the invention, provision is made for separately setting the sub-sieves of at least one sieve composed of at least two such sub-sieves.

In another embodiment, provision is made for varying the rotational speed of the fan in dependence on a measuring signal which provides a direct or indirect measure of the loading on the combine harvester.

Moreover, optimum setting of the cleaning mechanism can be effected by means of a combination of a sieve setting and a rotational speed of the fan.

The sensor may, for example, be in the form of a device for measuring the amount of straw in the feeder housing of the combine harvester. This device determines the amount of straw on the basis of the deflection of a feed chain or an intake auger or drum. Another form of sensor that could be mentioned would be a device for measuring the ground speed of the combine harvester. This is because the amount of crop picked-up by the combine harvester rises with increasing ground speed when the crop is uniformly distributed. Moreover, modern combine harvesters are equipped with a system for detecting the amount of crop being harvested. A setting for the cleaning mechanism could also be derived from the value of this quantity.

The setting of the cleaning mechanism in dependence on the sensor signal may be effected with the aid of an evaluating unit which uses an internally programmed function for calculating a control signal for the adjusting member.

As an alternative thereto, provision may be made for the evaluating unit to comprise a memory in which previously determined dependencies between the desired setting values and the sensor signal are stored in the form of a table or a characteristic curve or a family of characteristic curves, whereby the relevant control signal can be determined with the aid of the table or the characteristic curve.

In another embodiment of the invention, provision is made for the setting of the cleaning mechanism 1 to be effected after a time delay. Generally, the sensor 4 is located at a distance from the cleaning mechanism 1. This is done as a matter of necessity so that the cleansing setting derived from the sensor signal will then be effected only when the cleaning mechanism is actually subjected to the detected loading. This time delay is calculated on the basis of the path between the location of the sensor and the cleaning mechanism in a specific machine, the throughput speed of the crop through the harvesting machine and the known time required for the adjusting member to operate.

The invention will be explained in detail hereinafter with the help of the attached drawing.

Fig. 1 is a side view of the cleaning mechanism.

Fig. 2 is the differing sieve settings for various ground speeds.

The crop-chaff-short-straw mixture coming from the not- illustrated threshing and separating mechanisms is initially transported over the step-like upper surface of the grain pan 7 by means of a horizontal shaking motion thereof to the sieve device 2 where it is pre-sorted. The heavier crop falls downwardly therethrough whereas the lighter chaff and short-straw components are separated upwardly.

The cleaning mechanism 1 illustrated in Fig. 1 consists of a sieve device 2 comprising an upper sieve 2B and a lower sieve 2A, and a fan 3 which supplies a

blast of air to the lower and upper sieves 2A, 2B from below via suitable wind boards. The task of the lower sieve 2A is to separate out the contaminants which fell through the openings in the upper sieve 2B together with the crop. The crop falls through the lower sieve openings onto a catching and guide pan 10 which passes it to a grain feed auger 5 from where it is conveyed to the grain tank by means of an elevating conveyor. Items which are larger than the crop being harvested (e.g. unthreshed ears) cannot fall through the sieves 2A, 2B. They are swept along over the sieves by the air blast and the shaking motion of the sieves and are eventually returned to the thresher via a return pan 11 and the returns auger 6.

The sieves 2A, 2B are preferably in the form of louvered sieves consisting of toothed lamella of variable inclination which are disposed one behind the other. In order to set the width of the sieve opening, each sieve 2A, 2B comprises a known adjusting member 20A, 20B. This may, for example, be an electro-hydraulic adjusting member or an electro-mechanically driven screw which adjusts the inclination of the lamella through the medium of a lever.

It is advantageous if the magnitude of the openings in the upper sieve 2B can be varied over a range of 8 to 24 mm, whilst that of the openings in the lower sieve 2A can be varied over a range of 2 to 20 mm.

The sensor 4, whose measuring signal S/4 is a direct or indirect measure for the load exerted on the combine harvester by the crop and is thus a signal for indicating the loading on the cleaning mechanism, is only indicated schematically. As already mentioned, various types of sensor could be considered. Here, another type of sensor will be mentioned viz. one which measures the moisture content of the straw. This comes into consideration because the brittleness of dry stalks is greater and leads to an increased quantity of short-straws which in turn imposes a greater load on the cleaning mechanism 1. In addition, a sensor which measures the spacing of the concave from the threshing cylinder could, in accordance with the invention, be made use of since this spacing also has an effect upon the loading on the cleaning mechanism 1.

In practicing the technical teaching of the invention, the skilled person is not restricted to a particular type of sensor, but rather, the decisive factor is that a sensor 4 be provided whose measuring signal S/4 represents a measure for the load on the combine harvester, and in particular, for the load exerted by the crop on the cleaning mechanism, and that this measuring signal be used for setting the cleaning mechanism. In dependence on the type of sensor being used, the relationship between the load exerted by the crop and the measuring signal is determined, and the wanted cleansing setting to be derived therefrom is imaged with the aid of a program or is stored in the form of a table, a characteristic curve or a family of characteristic curves. It is also quite conceivable for the cleansing setting to be derivable from a plurality of detectable influential factors or combinations thereof.

For example, an evaluating unit 8 may be provided on the combine harvester wherein a control signal S/20A, S/20B for setting the wanted sieve opening is calculated by means of a programmed function Φ in dependence on the measuring signal S/4: Φ (S/4) => S/20A or S/20B.

As an alternative to calculating the control signals for the adjusting members, provision is made for the evaluating unit 8 to comprise a store in which a plurality of previously determined dependencies between the wanted setting values, here for example, the sieve opening widths or the control signals S/20A, S/20B required therefor, and the measuring signal S/4 are stored in the form of a table or a characteristic curve or a family of characteristic curves.

As illustrated in Fig. 1, it is preferable for the rotational speed of the fan to be supplied to the evaluating unit in the form of a signal S/3. When using a family of characteristic curves, provision is then made, inter alia, for selecting a characteristic curve in dependence on the rotational speed of the fan, or, when using a programmed function, certain parameters are altered in dependence on the rotational speed of the fan.

Moreover, means (e.g. keyboards, touch screens, or the like) are preferably provided for allowing the programmed function or the stored dependencies to be altered by the driver of the combine harvester.

The signal lines from the sensor 4 to the evaluating unit 8, the evaluating unit itself, and also the signal lines for the control signals to the adjusting members are preferably integral components of a network system installed in the combine harvester.

The setting of the cleaning mechanism in dependence on the sensor signal S/4 can be effected fully automatically. The sieve opening or the fan speed are altered by an associated regulating circuit until the predetermined preferred values are obtained. This regulator may be installed directly in the adjusting arrangement or may form a part of the evaluating unit 8. The individual control values are supplied to the respective regulators by known means and they may also be made available for other evaluation process or as test values for further setting actions.

It is also possible to set the cleansing setting manually in that the driver of the combine harvester is made aware of the settings proposed in accordance with the invention by means of a control panel monitor so that he can implement them by pressing a button for example.

Furthermore, a warning device, an optical or an acoustic device for example, is provided for warning the driver should the setting values e.g. the sieve opening width and/or the change in the sieve opening and/or the rotational speed of the fan have exceeded predetermined limiting values.

Fig. 2 depicts how the widths of a sieve (e.g. the upper sieve) are set in dependence on the ground speed signal. In a field where the crop is uniform, an average ground speed indicates an average throughput of crop. As the ground speed increases, so does the throughput, this thus leading, in accordance with the invention, to an automatic enlargement of the sieve opening width and thereby ensures an optimum cleansing action. Should the ground speed become slower, for example, prior to turning the plough, the opening width of the sieve will be

correspondingly decreased. This thus prevents a worsening of the cleansing quality as the loading on the cleaning mechanism decreases.

Furthermore, provision is made in another embodiment of the invention, for the setting range of the cleaning mechanism 1 to be predefined on the basis of limiting values. This will then prevent the cleaning mechanism from being adjusted to such an extent that it would reach the end stops of the adjusting member when the combine harvester is freewheeling during the harvesting operation for example.

Claims:

1. A device on a combine harvester incorporating a cleaning mechanism which comprises a sieve device including at least one sieve for cleaning the crop produced by the threshing and separating mechanisms and at least one adjustable fan for forcing a blast of air through the sieve device, whereby the opening widths of the sieve device are adjustable by means of at least one adjusting member and/or the fan is adjustable mechanically, said combine harvester including at least one sensor whose measuring signal is dependent on the loading to which the combine harvester is subjected by the crop but which is independent of the setting of the cleaning mechanism, wherein the setting of the sieve opening width is effected automatically in dependence on the measuring signal from the sensor.

2. A device on a combine harvester as in claim 1, wherein the setting of the sieve opening width and the rotational speed of the fan is effected automatically in dependence on the measuring signal from the sensor.

3. A device on a combine harvester as in claim 1, wherein the sensor detects the amount of straw in the feeder housing of the combine harvester.

4. A device on a combine harvester as in claim 1, wherein the sensor detects the moisture content of the straw.

5. A device on a combine harvester as in claim 1, wherein the sensor detects the amount of crop being harvested.

6. A device on a combine harvester as in claim 1, wherein the sensor detects the ground speed of the combine harvester.

7. A device on a combine harvester as in claim 1, wherein the setting of the opening width of the sieve device is dependent on the rotational speed of the fan.

8. A device on a combine harvester as in claim 1, including an evaluating unit for calculating a control signal representative of the desired cleansing setting by means of a programmed function in dependence on the measuring signal.

9. A device on a combine harvester as in claim 8, wherein the evaluating unit comprises a memory in which a plurality of previously determined dependencies between the desired sieve opening widths and/or the rotational speed of the fan and at least one measuring signal are stored in the form of a table or a characteristic curve or a family of characteristic curves, whereby the control signal is determined with the aid of the table or the characteristic curve.

10. A device on a combine harvester as in claim 8, wherein the evaluating unit determines the cleansing setting from a combination of several measuring signals.

11. A device on a combine harvester as in claim 8, wherein a new setting for the cleaning mechanism is produced by the evaluating unit in such a manner that the altered setting only becomes effective when the crop has traversed the path between the sensor and the cleaning mechanism.

12. A device on a combine harvester as in claim 1, including means for altering the programmed function and the stored dependencies.

13. A device on a combine harvester as in claim 1, wherein the sieve device comprises an upper sieve and a lower sieve whose opening widths are each adjustable by means of a respective adjusting member whereby the opening width of the upper sieve and the opening width of the lower sieve are adjustable to different extents in dependence on the measuring signal.

14. A device on a combine harvester as in claim 13, wherein at least one of the upper and lower sieves comprises at least two sub-sieves whose opening widths are each adjustable by means of a respective adjusting member whereby the opening widths of the sub-sieves are adjustable to different extents in dependence on the measuring signal.

15. A device on a combine harvester as in claim 1, including means for restricting the possible adjustment ranges by predetermined limiting values.

16. A device on a combine harvester incorporating a cleaning mechanism which comprises a sieve device having opening widths and including a sieve for cleaning a crop produced by the threshing and separating mechanisms, an adjustable fan for forcing a blast of air through the sieve device, means for adjusting at least one of the opening widths of the sieve device and the fan speed, and a sensor having a measuring signal dependent on the loading to which the combine harvester is subjected by the crop but which is independent of the setting of the cleaning mechanism, wherein the setting of the sieve opening width is effected automatically in dependence on the measuring signal from the sensor.

Combine with a Device for Automatic Cleaning Regulation

Abstract of the Disclosure:

The invention relates to a combine with a cleaning device (1), having a screening device (2) with at least one screen (2A, 2B) in which the harvested products conveyed to the thresher and to the separation device are cleaned and at least one adjustable blower (3) for exposing the screening device (3) to an air flow. The width of the openings of the sifting device (2) and the revolutions of the blower (3) can be mechanically regulated by at least one regulation organ. According to the invention, at least one sensor (4) is provided whose measuring signal (S/4) directly or indirectly indicates a quantity of harvested products loaded on the combine, especially on the cleaning device. Optimal regulation of the cleaning device, especially the width of the openings of the screen, is performed by an adjusting organ (20A, 20B) depending on the signal (S/4) of the sensor (4).

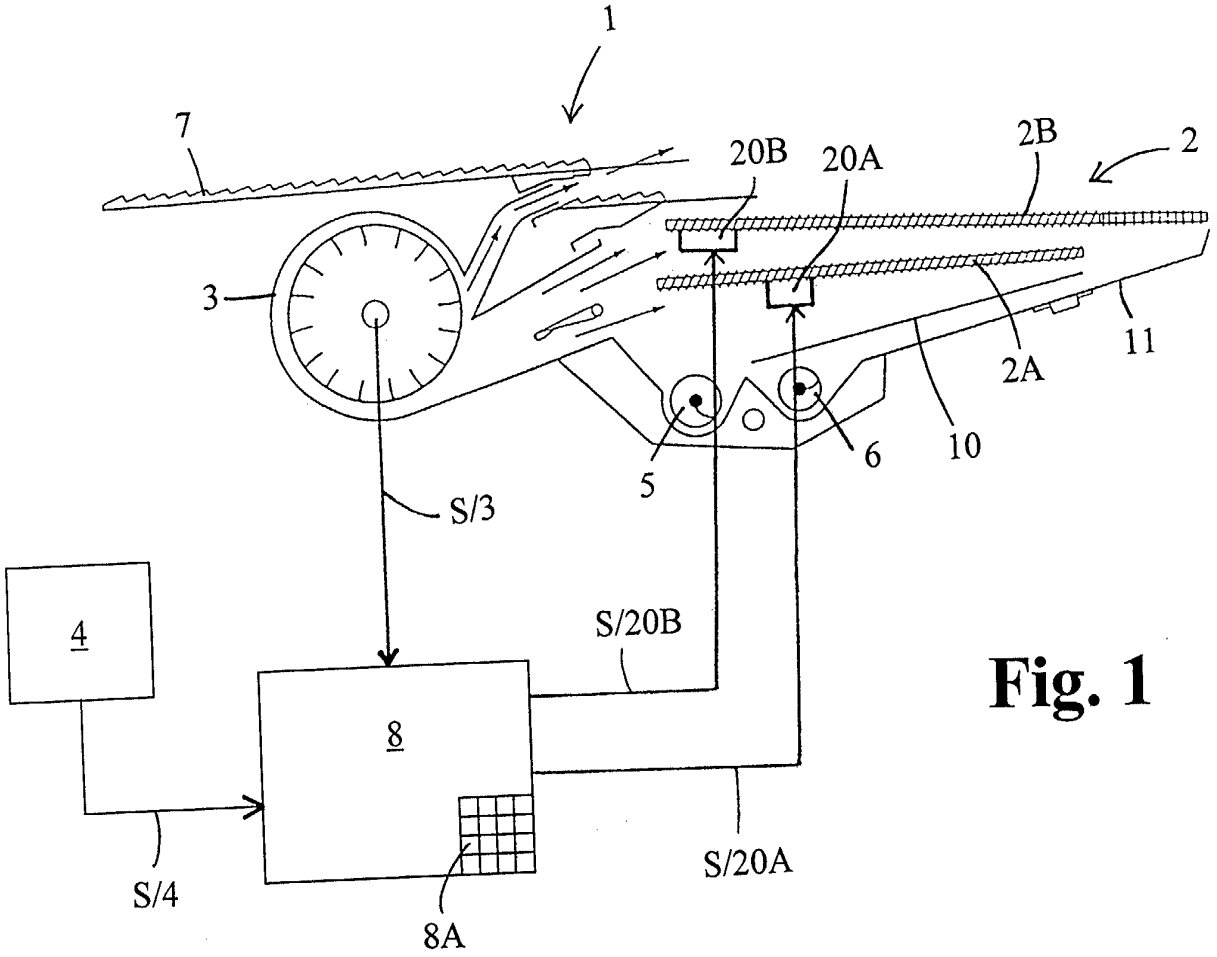

Fig. 1

Low Ground Speed

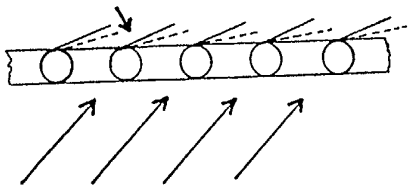

Fig. 2A

Normal Ground Speed

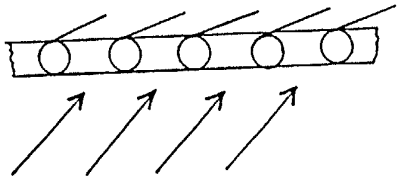

Fig. 2B

High Ground Speed

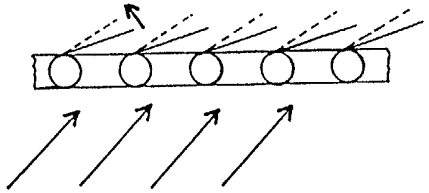

Fig. 2C

DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY

I, Dr. Norbert Diekhans, residing in Gütersloh, Germany, declare that I am a citizen of Germany, and that I believe I am the original and first inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled:

Combine With a Device for Automatic Cleaning Regulation

the specification of which is attached hereto.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims.

I acknowledge the duty to disclose to the Patent and Trademark Office all information known to be material to patentability as defined in §1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of **Prior Foreign Application 198 07 145.0 filed in Germany on 20 February 1998.**

There is no foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed.

I hereby appoint Robert E. Muir, Patent Office Reg. No. 23,017, Kevin M. Kercher, Patent Office Reg. No. 33,408, Richard J. Musgrave, Patent Office Reg. No. 44,960, telephone number 309-637-4900, and H. Frederick Rusche, Patent Office Reg. No. 45,061, telephone number 314-421-4800, my attorneys and/or agents, with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected with this application. Please address all correspondence to:

Robert E. Muir
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401 Main Street, Suite 1400
Peoria, Illinois 61602-1241

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements are made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Norbert Diekhans

3. Juli 2000
Date

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